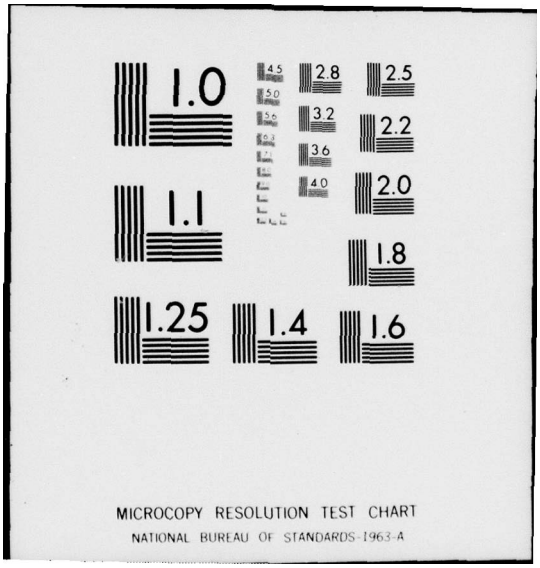
AD-A036 980 NATIONAL AVIATION FACILITIES EXPERIMENTAL CENTER ATL--ETC F/G 17/7
MANUAL OPERATIONS AT JACKSONVILLE ARTCC.(U)
APR 70 A C BUSCH

UNCLASSIFIED NL

1 OF 1
ADA036980

END

DATE
FILMED
4-77


1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2
2.5
2.8
3.2
3.6
4.0
4.5
5.0
5.6
MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

(1)

B 6

(9) DATA REPORT,

ON THE

(6) MANUAL OPERATIONS AT JACKSONVILLE ARTCC.

(10) Allen C. Busch

afta p 218

Project 167-641-01X
"ATC SYSTEM ANALYSIS - BEFORE AND AFTER
NAS ENROUTE STAGE A"

SOURCE

National Aviation Facilities Experimental
Center

~~Washington, D.C. 20591~~ Atlantic City

402160

UNLIMITED AVAILABILITY

TEST AND EVALUATION DIVISION
HUMAN ENGINEERING BRANCH
(11) APRIL 1970

(12) 36p.

402160 B

INTRODUCTION

The purpose of this project is to measure, by collecting factual data, the effect of introducing NAS Enroute Stage A equipment in the ARTCC at Jacksonville, Florida. The intent is to obtain measurements on the enroute air traffic controller activities before the introduction of any new equipments, and then to make subsequent measurements after the introduction of new equipments to determine what changes resulted on the part of the controller activities.

This report is a summary of the measurements made before the installation of any new automation equipment in the Jacksonville ARTCC, essentially a manual environment. Subsequent reports will be issued after measurements are made on Functional Package A and Functional Package B implementation.

METHOD OF APPROACH

This effort provides a description of the controller activities in the Jacksonville (JAX) ARTCC. The data being reported on were taken in October 1968. Since there will be a reasonable time span (it could be 2 years or more) between the sampling of "before" activities and the "after" activities, a basis of comparison that will have some validity is necessary. The most basic criteria appear to be controller activity per aircraft per unit time. In conjunction with this is the relative number of aircraft per controller for any one time interval and the relative amount of time that an aircraft is under the jurisdiction or control of the controller. Thus, the format of the data and analysis for this report is predicated upon comparisons that are most likely to be made when "after" data become available.

An attempt was made to record and time all the observable activities of each controller position function in the JAX ARTCC (i.e., the "R" controller, the "A" controller, the "D" controller, the coordinator and the flight data persons). For expediency and accuracy of data reduction, the voice communications were recorded, reduced, and analyzed separately.

Thus, the effort breaks down into two discernible parts: activity analysis and voice communications analysis.

Activity Analysis

An analysis was made of the various functions or activities that each controller performs. A listing was made of these and coordinated

with field facility personnel to assure that it was complete. A list of controller activities with an alpha coding is included as Appendix A.

A preliminary examination of the work activity at the JAX Center indicated that the major amount of aircraft activity associated with commercial and general aviation was concentrated in the sectors along the east coast. Since there were 25 sectors each with their appropriate complement of controllers, it was decided to limit the amount of data collected and not to perform an activity analysis for all sectors and all controllers. Thus, the activity analysis concentrated on those sectors which had the highest aircraft activity along the eastern half of the facility: five high altitude sectors, D-30, D-31, D-32, D-34 and D-35; three low altitude sectors, D-4, D-5, D-6; and four transitional sectors, D-7, D-8, D-9, and D-10. Each of these sectors had more than one controller (i.e., an "R" controller, "A" controller, "D" controller and coordinator), though not all sectors had a full complement. It was not unusual for some sectors to be sharing an "A" controller and coordinator. Though only 12 sectors were analyzed for activity analysis, 35 operator-positions were involved.

A team of six observers (air traffic control specialists) used kymographs - strip records with precision synchronous motors - to mark the onset and completion of each activity and to note the type of activity as listed in Appendix A. This procedure allowed the observers to record overlapping activities. It was not unusual for a controller to perform some manual function such as marking shrimp boats or flight data strips while he was in communication with an aircraft.

Each of the controller positions was sampled for approximately 30 minutes at a time with no position being sampled less than five times. The sampling excluded the very slow (relative to aircraft density) periods of time and thus the criteria were used of sampling only the median to high traffic conditions relative to the peak traffic that JAX experiences.

It is important to note that the activity analysis covered only the overt activities of the controller. The radar (R) controller, and to a lesser extent, the coordinator (C) and assistant controller (A) spend a significant part of their time visually monitoring the radar scope observing the aircraft movements, anticipating future events and formulating in their mind what action(s) to take next. This type of activity would be very difficult to measure with any degree of accuracy or reliability. No attempt was made to measure this activity, but it is recognized that it is an absolute necessity in controlling aircraft and a significant part of the basic job.

Communication Activity Analysis

For the communications analysis all 25 sectors within the JAX Center were sampled. This procedure allowed for an analysis of or comparison of those sectors which were included in the activity analysis with those that were not on the basis of communication. This type of comparison will indicate the validity of only sampling the activity for 12 of the 25 sectors.

Each time that a specific person (pilot or controller) spoke was identified as a transmission or communications transmission. Usually, when a transmission was initiated a response from the addressee occurs and this total communication exchange between two persons, which usually entails more than one transmission, was called a transaction or communications transaction (see Figure 1).

All the communications were analyzed for the following characteristics:

1. Who was the initiator (e.g., American Airlines 312, or the radar controller for sector D-10, or the adjacent facility, etc.)?

2. The ratio of pilot to controller initiated communication transactions.

3. How much elapsed time occurred for each communication transmission and communications transaction?

4. What was the predominant coding or type of each transmission (see Appendix B for coding scheme and definition of message type)?

5. What are the characteristics of the initiator and addressee (e.g., airline, military or general aviation; jet or prop type airplane; beacon user; high altitude enroute sector; etc.)?

6. At any one instant how many of the communications channels are in use and how many users are there?

RESULTS

The analysis of the results indicates several cautions in interpreting the results. Previous studies of a similar nature (Davis, C. G. and Wallace, W. H., "The Controller in Positive and Traditional Control," Courtney and Company, Report no. 58, Contract FAA/BRD-301,

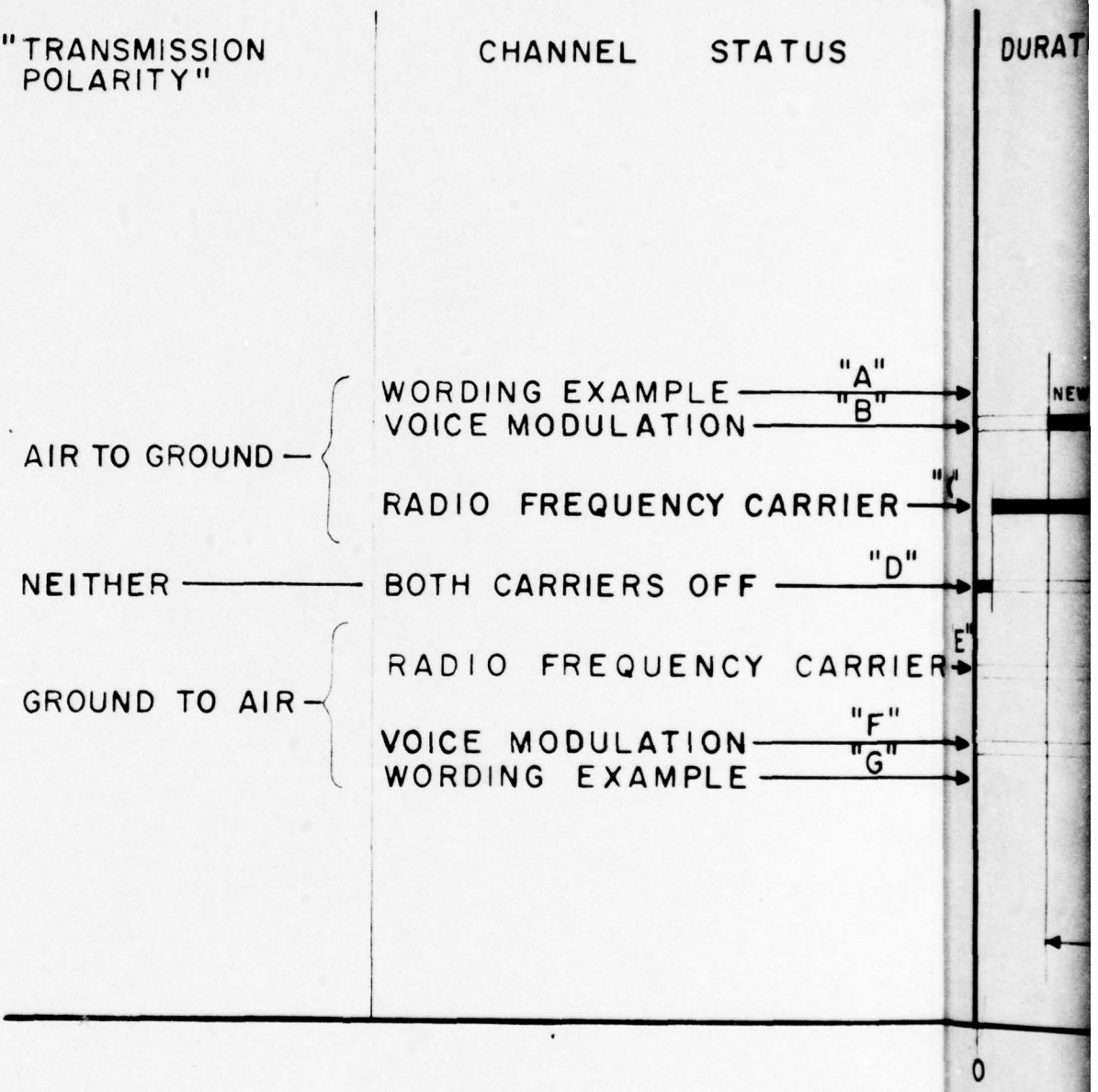
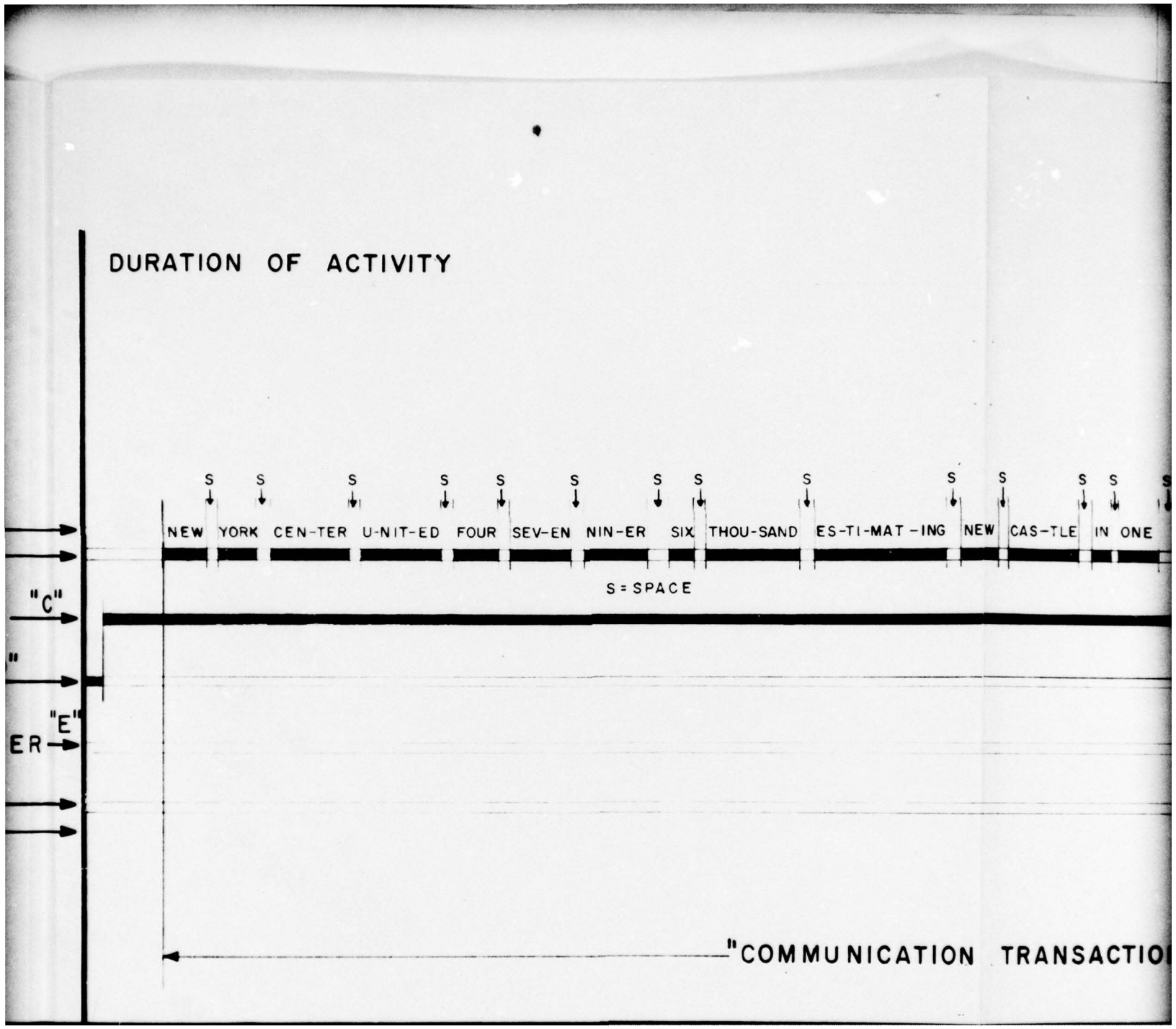
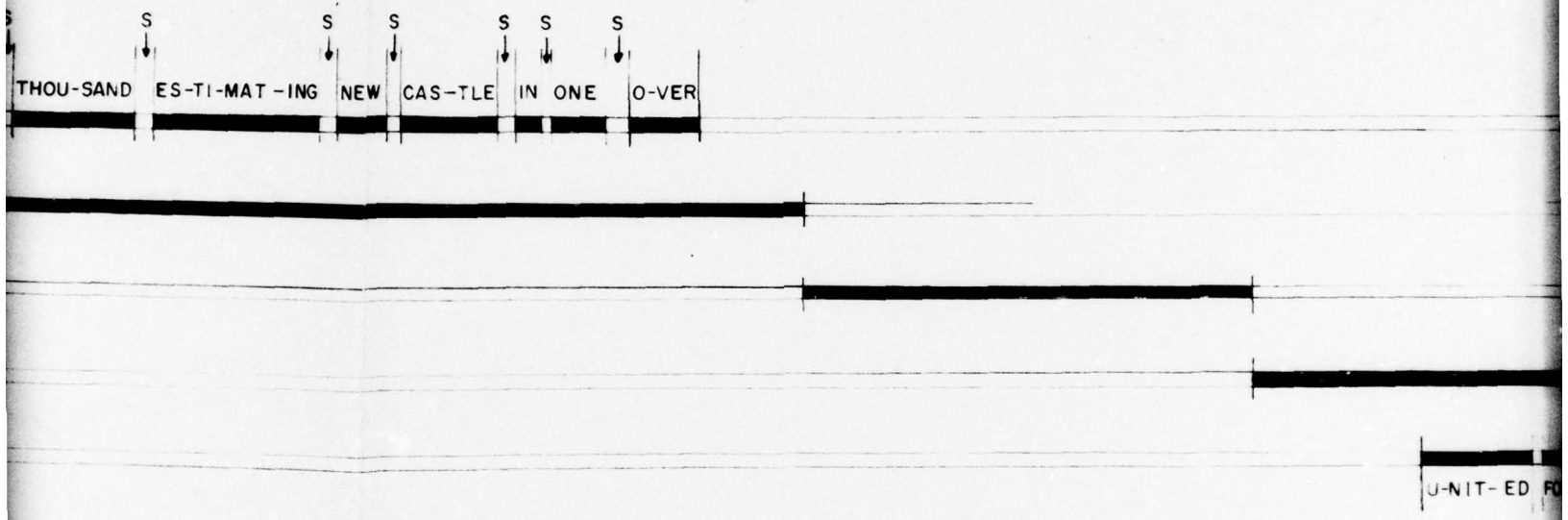


DIAGRAM OF THE ELEMENTS OF THE COMMUNICATION TRAN
DATE 1/31/70


DURATION OF ACTIVITY
S S S S S S S S S S S S
NEW YORK CEN-TER U-NIT-ED FOUR SEV-EN NIN-ER SIX THOU-SAND ES-TI-MAT-ING NEW CAS-TLE IN ONE
S = SPACE
"C"
"E"
"COMMUNICATION TRANSACTIO

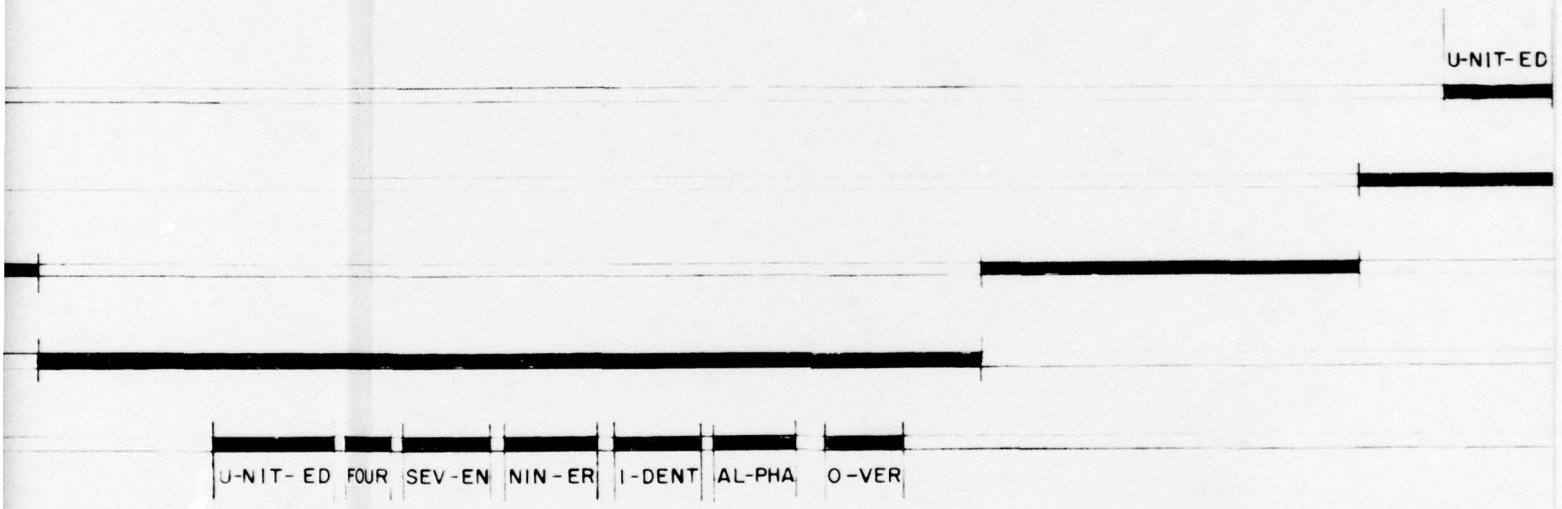


"COMMUNICATION TRANSACTION" (CT) # 1

5

10

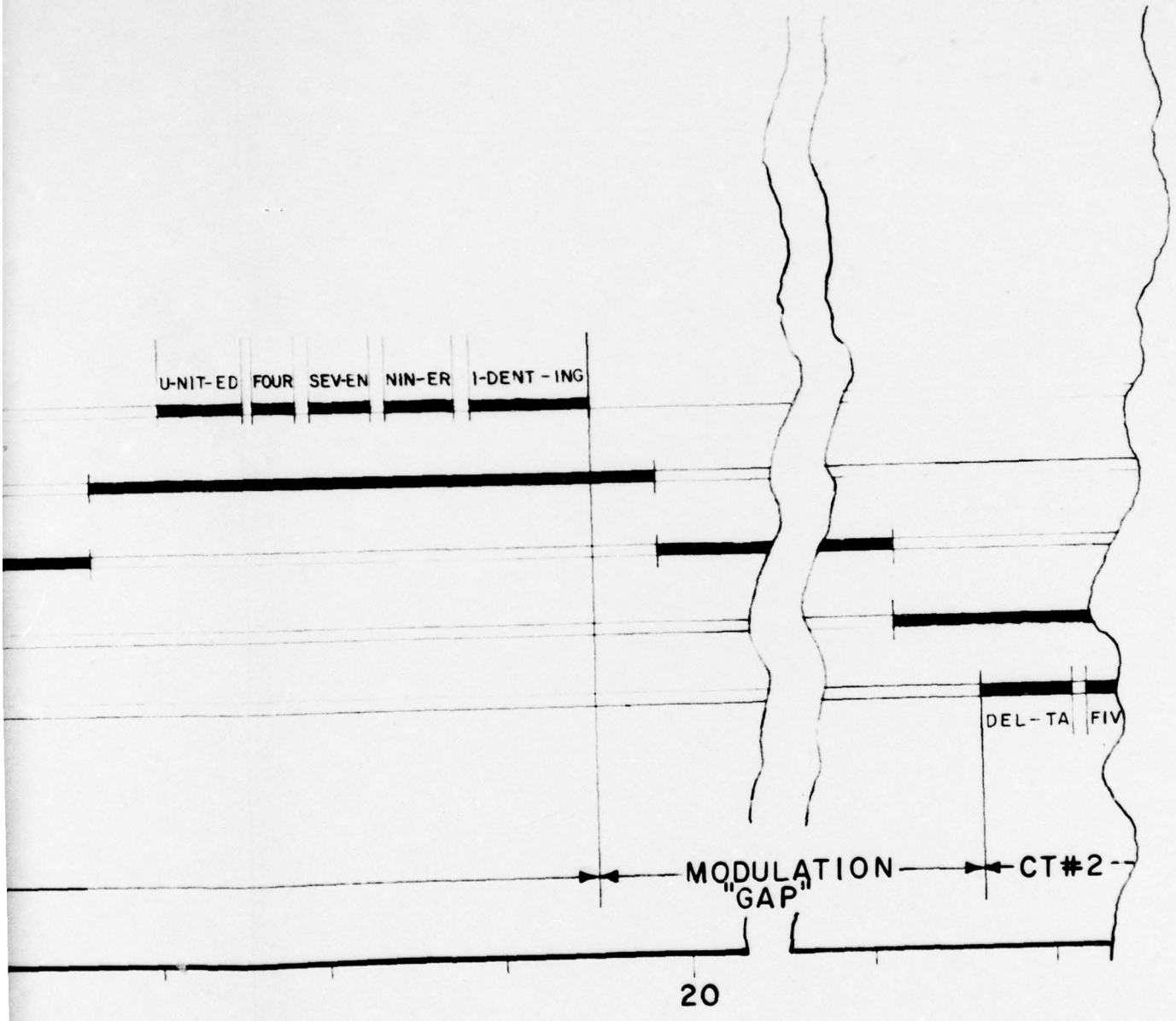
TIME (SECONDS)



15

CONDS)

4


U-NIT-ED FOUR SEV-EN NIN-ER I-DENT-ING
DEL-TA FIV
MODULATION "GAP"
CT#2
20

5

1961) used a 30-minute sampling period for the activity analysis as did this study. The intent for future comparisons is the amount and type of activity for the control of an aircraft under various conditions such as number of aircraft per unit time, number of aircraft under control at any one instant in time, the average time an aircraft is under control by any one controller, etc.. The half-hour sampling for examining the amount of activity, in time, attributable on a per aircraft basis, did not prove to be a good sampling interval. For this type of data, only those aircraft that both entered and departed the sector or controllers' jurisdiction provide usable data. A controller might control some 7 to 12 different aircraft during any one-half hour interval; however, out of that number there are probably only two to four aircraft that both entered and departed during that half hour. Thus, a half-hour sampling does not provide a very large sample of data relative to activity per aircraft whereas an hour or a 2-hour sample provides a significant improvement in usable data per sampling period. A 2-hour sample provides two to four times more data than 4 half-hour samples.

The second area of caution in interpreting the data arises because not enough of the "activity" data was taken simultaneously in time with the "communications" data. A larger sampling interval for both the activity and communication samples is necessary; an increase in the number of samples and an increase in the number of coincident activity and communication samples will be necessary for future sampling so that the data base generated can be generalized with greater accuracy.

Since some of the data that is "common" to both the activity analysis such as "average on-frequency time" and the communications analysis such as "average communications transaction time" indicate some small differences, the activity analysis and communication analysis are presented separately.

Activity Analysis

Tables 1, 2 and 3 present data derived from the activity analysis. Table 1 presents the percent of time a controller was busy by the type of position and by the type of sector. Furthermore, it indicates the percent of time that two activities were occurring simultaneously and that the three activities were occurring simultaneously. No activity was observed for the coordinator (C position) at the low altitude sectors because there was no manning of this position while the data were being collected. The reader should be aware that for those operators who have need of data from a visual display, such as the radar controller using his PPI, no data were taken relative to the time spent observing

their displays only. This visual search and attention to the displays is a necessary and integral part of the controller's job but is not readily amenable to quantitative analysis.

Table 2 presents data indicating the average length of time (in seconds) for the controller to perform a specific function. Also indicated is the percent of the total sample that any one function occupied (e.g., the radar controller (R) spent .179 of his total time using his radio (OF)). This table indicates the amount of activity for both the specific functions (e.g., gives handoff to adjacent sector (GHS)) and the general function (e.g., handoffs (HNDOFF)).

Table 3 details some of the activity data by sector and position type. The asterisk in the table indicates that that position was not manned and therefore no data were taken. Where a single entry is bracketing more than one sector, this indicates that one operator was functioning in that capacity for those sectors (e.g., one "A" controller was servicing both sectors D-5 and D-6). The second column presents the percent of total observed activity time that was occupied by "on frequency." The third column presents the average length of time, in seconds, for any one "on frequency" event. The fourth column presents the average number of "on frequency" events that occurred per hour. The fifth column presents the average number of man minutes of activity per aircraft per sector. This was determined by summing the time for each operator (e.g., at sector D-4, only the "R" and "D" controller worked that sector) at a single sector over an hour's time and dividing by the number of aircraft handled. Since the estimate of number of aircraft handled is not highly reliable, as previously discussed, this statistic is not very reliable. It is presented here more for the type of analysis and data available rather than for absolute accuracy. If the data are treated in this manner in the "after" phase, this statistic will be useful and reliable on a comparative basis but it is not proposed that these figures be used as an absolute basis of the number of man minutes necessary to control an aircraft per sector.

The data also indicated that an aircraft was in low altitude sector on the average of 9.18 minutes, in a low transitional sector on the average of 11.95 minutes, and in a high sector on the average of 12.16 minutes.

Communication Activity Analysis

Tables 4 and 5 depict some of the data from the communication analysis. Table 4 presents the mean length of time in seconds for any one message type to occur and also the frequency with which each

message type occurred, by sector type, e.g., a 110 message (aircraft vectoring or heading message) took on the average of 3.0 seconds of transmission time and there were 49 of them for every 1,000 messages that occurred for the low transitional sectors.

Table 5 presents a summary of data from the voice communications tapes by sectors. Column 1 indicates the average number of pilot initiated communications transactions per hour. Column 2 presents the average number of radar controller initiated communications transactions per hour. Column 3 presents the average number of communications transactions initiated per hour per sector (sum of columns 1 and 2). Column 4 presents the average length of time of a communications transaction in seconds. Column 5 presents the average number of aircraft worked per hour. Column 6 presents the average number of communications transactions per aircraft (column 3 divided by column 5). Column 7 presents the channel utilization, in percent, for the total communication sample.

TABLE 1

ACTIVITY BY SECTOR TYPE AND POSITION

Sector Type/Position	% Time Busy	% Time 1 Activity	% Time 2 Activities	% Time 3 Activities
Transitional sectors				
C Position	.241	.211	.027	.003
R	.375	.337	.037	.000
A	.328	.307	.021	.000
D	.300	.265	.035	.000
High altitude sectors				
C Position	.190	.179	.011	.000
R	.326	.299	.026	.000
A	.567	.516	.050	.001
D	.346	.309	.036	.001
Low altitude sectors				
C Position	*	*	*	*
R	.380	.356	.023	.000
A	.276	.274	.001	.000
D	.393	.333	.059	.002
Summary				
C Position	.213	.193	.018	.001
R	.354	.325	.028	.000
A	.409	.381	.028	.000
D	.348	.304	.042	.001
All Positions	.349	.316	.032	.001

* = not observed

TABLE 2

ACTIVITY CODE BY POSITION TYPE

Position	Code	Mean Time (Sec.)	% of Total Activity	Code	Mean Time (Sec.)	% of Total Activity	Code	Mean Time (Sec.)	% of Total Activity
C Position	OF	7.00	.000	LC	7.00	.002	PS	74.33	.007
R	OF	12.51	.179	LC	2.03	.001	PS	28.75	.001
D	OF	12.60	.001	LC	5.54	.001	PS	32.25	.011
A	OF	0.00	.000	LC	6.80	.001	PS	37.23	.117
Total	OF	12.51	.063	LC	4.14	.001	PS	36.76	.028
C Position	SB	4.04	.013	MS	5.47	.022	STRIPS	6.35	.040
R	SB	3.66	.059	MS	3.06	.020	STRIPS	3.09	.023
D	SB	10.64	.030	MS	3.51	.060	STRIPS	4.04	.120
A	SB	0.00	.000	MS	5.20	.049	STRIPS	12.38	.278
Total	SB	4.67	.033	MS	3.77	.040	STRIPS	5.98	.109
C Position	GI	13.50	.003	SS	5.54	.009	GHF	19.72	.015
R	GI	9.53	.003	SS	2.26	.001	GHF	22.58	.017
D	GI	18.55	.016	SS	3.71	.027	GHF	22.79	.006
A	GI	18.32	.010	SS	4.85	.022	GHF	0.00	.000
Total	GI	16.59	.009	SS	3.99	.015	GHF	22.15	.010
C Position	AB	1.00	.000	BS	3.65	.002	RHF	22.22	.012
R	AB	2.45	.002	BS	2.36	.001	RHF	16.22	.009
D	AB	6.13	.000	BS	4.46	.021	RHF	18.56	.005
A	AB	0.00	.000	BS	10.89	.018	RHF	0.00	.000
Total	AB	2.75	.001	BS	5.22	.012	RHF	17.80	.006

TABLE 2 (Continued)

Position	Code	Mean Time (Sec.)	% of Total Activity	Code	Mean Time (Sec.)	% of Total Activity	Code	Mean Time (Sec.)	% of Total Activity
C Position	GHS	31.48	.021	RHF/RHS	24.49	.027	REF	45.00	.004
R	GHS	16.33	.019	RHF/RHS	13.93	.031	REF	0.00	.000
D	GHS	21.75	.005	RHF/RHS	19.68	.008	REF	21.05	.013
A	GHS	0.00	.000	RHF/RHS	0.00	.000	REF	24.59	.013
Total	GHS	18.79	.010	RHF/RHS	15.83	.016	REF	22.78	.007
C	RHS	26.88	.014	GHS/RHS	29.42	.035	PEF	31.75	.004
R	RHS	13.16	.022	GHS/RHS	14.48	.041	PEF	27.00	.000
D	RHS	21.68	.003	GHS/RHS	21.72	.008	PEF	31.03	.024
A	RHS	0.00	.000	GHS/RHS	0.00	.000	PEF	49.85	.087
Total	RHS	14.83	.010	GHS/RHS	16.60	.021	PEF	41.13	.026
C	GHF/RHF	20.77	.028	HNDOFF	24.83	.063	PES/PEF	24.57	.005
R	GHF/RHF	19.92	.026	HNDOFF	16.21	.067	PES/PEF	27.00	.000
D	GHF/RHF	20.64	.011	HNDOFF	21.09	.020	PES/PEF	26.57	.031
A	GHF/RHF	0.00	.000	HNDOFF	0.00	.000	PES/PEF	44.91	.098
Total	GHF/RHF	20.23	.016	HNDOFF	18.01	.037	PES/PEF	35.54	.031
C	GHF/GHS	25.09	.036	PES	15.00	.001	REF/PEF	37.43	.008
R	GHF/GHS	18.80	.037	PES	0.00	.000	REF/PEF	27.00	.000
D	GHF/GHS	22.31	.011	PES	17.73	.007	REF/PEF	26.66	.037
A	GHF/GHS	0.00	.000	PES	25.80	.012	REF/PEF	44.13	.099
Total	GHF/GHS	20.27	.020	PES	20.62	.005	REF/PEF	34.91	.033

TABLE 2 (Continued)

Position	Code	Mean Time (Sec.)	% of Total Activity	Code	Mean Time (Sec.)	% of Total Activity	Code	Mean Time (Sec.)	% of Total Activity
C Position	ESTMTS	30.70	.010	RRS	20.00	.002	RRF/RRS	34.71	.008
R	ESTMTS	11.25	.000	RRS	11.17	.001	RRF/RRS	10.44	.001
D	ESTMTS	23.51	.048	RRS	16.32	.018	RRF/RRS	17.15	.030
A	ESTMTS	36.14	.124	RRS	17.11	.002	RRF/RRS	17.00	.004
Total	ESTMTS	29.42	.042	RRS	16.24	.007	RRF/RRS	17.40	.013
C	PRF	19.75	.002	PRF/PRS	21.00	.005	REVSNS	27.86	.012
R	PRF	0.00	.000	PRF/PRS	16.00	.000	REVSNS	11.46	.001
D	PRF	28.22	.024	PRF/PRS	22.32	.047	REVSNS	19.95	.077
A	PRF	43.25	.003	PRF/PRS	36.67	.005	REVSNS	24.38	.009
Total	PRF	28.46	.009	PRF/PRS	22.71	.018	REVSNS	20.19	.031
C	PRS	22.67	.002	PRF/RRF	32.75	.008	FPLNS	0.00	.000
R	PRS	16.00	.000	PRF/RRF	9.00	.000	FPLNS	0.00	.000
D	PRS	18.28	.023	PRF/RRF	23.90	.036	FPLNS	0.00	.000
A	PRS	31.40	.002	PRF/RRF	27.40	.004	FPLNS	0.00	.000
Total	PRS	18.73	.009	PRF/RRF	24.19	.015	FPLNS	0.00	.000
C	RRF	45.75	.006	PRS/RRS	21.33	.004	ID	37.00	.001
R	RRF	9.00	.000	PRS/RRS	12.38	.001	ID	19.00	.000
D	RRF	18.48	.012	PRS/RRS	17.37	.040	ID	31.33	.012
A	RRF	16.83	.002	PRS/RRS	22.21	.005	ID	2.00	.000
Total	RRF	19.22	.005	PRS/RRS	17.53	.016	ID	30.59	.004

TABLE 2 (Continued)

Position	Code	Mean Time (Sec.)	% of Total Activity	Code	Mean Time (Sec.)	% of Time Activity	Code	Mean Time (Sec.)	% of Total Activity
C Position	CD	7.23	.014	RD	0.00	.000	DS	2.00	.000
R	CD	5.27	.014	RD	0.00	.000	DS	0.00	.000
D	CD	6.84	.001	RD	7.69	.002	DS	15.00	.000
A	CD	8.31	.008	RD	10.50	.000	DS	15.91	.048
Total	CD	5.99	.008	RD	7.85	.001	DS	15.82	.010
C	CS	15.48	.032	CR	5.46	.022	CC	17.25	.004
R	CS	11.61	.024	CR	7.20	.001	CC	5.81	.002
D	CS	15.07	.031	CR	6.09	.016	CC	6.03	.002
A	CS	23.37	.007	CR	10.00	.001	CC	7.50	.000
Total	CS	13.92	.024	CR	5.98	.008	CC	6.90	.002
C	CF	15.76	.010	COORDN	9.45	.086	RES	0.00	.000
R	CF	17.94	.008	COORDN	8.56	.049	RES	6.00	.000
D	CF	23.32	.025	COORDN	11.84	.083	RES	15.79	.004
A	CF	30.44	.008	COORDN	15.65	.025	RES	18.02	.013
Total	CF	21.94	.014	COORDN	10.53	.060	RES	16.73	.004
C	CA	16.00	.003	INTPHN	21.15	.129	AR	0.00	.000
R	CA	5.00	.000	INTPHN	14.85	.101	AR	8.88	.001
D	CA	9.00	.007	INTPHN	20.33	.216	AR	0.00	.000
A	CA	111.00	.002	INTPHN	33.71	.148	AR	0.00	.000
Total	CA	10.40	.003	INTPHN	20.17	.154	AR	8.88	.000

TABLE 2 (Continued)

Position	Code	Mean Time (Sec.)	% of Total Activity	Code	Mean Time (Sec.)	% of Total Activity	Code	Mean Time (Sec.)	% of Total Activity
C Position	AR/AB	1.00	.000	RES/REF	45.00	.004	BL	0.00	.000
R	AR/AB	3.01	.002	RES/REF	6.00	.000	BL	0.00	.000
D	AR/AB	6.13	.000	RES/REF	19.43	.017	BL	0.00	.000
A	AR/AB	0.00	.000	RES/REF	20.71	.026	BL	52.27	.009
Total	AR/AB	3.24	.001	RES/REF	20.16	.012	BL	52.27	.002
C	SC	0.00	.000	ID/RD	37.00	.001	SK	0.00	.000
R	SC	3.00	.000	ID/RD	19.00	.000	SK	0.00	.000
D	SC	6.00	.000	ID/RD	21.63	.014	SK	0.00	.000
A	SC	37.91	.006	ID/RD	7.67	.000	SK	36.50	.002
Total	SC	32.77	.001	ID/RD	21.28	.005	SK	36.50	.000
C	RES/PES	15.00	.001	FS	0.00	.000			
R	RES/PES	6.00	.000	FS	0.00	.000			
D	RES/PES	16.94	.011	FS	8.00	.000			
A	RES/PES	20.98	.025	FS	31.62	.006			
Total	RES/PES	18.63	.009	FS	28.47	.001			

TABLE 3

ACTIVITY BY SECTOR

Low Altitude Sectors	% Time Busy (by Position) R	A	D	C	% Time on Frequency	Average of Time (seconds)	Average no. of OF's per Hour	Average no. of Man Minutes per Aircraft
D-4	.38	*	.31	*	.23	12.0	67.5	2.45 minutes
D-5	.42	.28	.44	*	.21	12.4	59.5	3.31 minutes
D-6	.31		.39	*	.16	15.8	35.2	3.51 minutes
Average	.37	.28	.38		.20	12.9	54.8	3.07 minutes
Transitional Sectors								
D-7	.43	.38	.34	*	.26	16.6	55.2	3.38 minutes
D-8	.29		.22	*	.14	14.4	34.0	3.43 minutes
D-9	.41	.12	.34	.20	.25	15.6	58.4	3.21 minutes
D-10	.38	.38	.27	.31	.24	12.8	67.1	4.99 minutes
Average	.38	.29	.29	.26	.22	14.7	53.9	3.73 minutes
High Altitude Sectors								
D-30	.39	.54	.38		.14	11.8	43.0	4.57 minutes
D-31	.34	.64	.39	.14	.16	13.5	42.8	4.61 minutes
D-32	.29		.27		.12	9.4	47.7	3.29 minutes
D-34	.19	.52	.26	.20	.08	10.8	27.5	4.03 minutes
D-35	.43		.42		.21	11.0	67.3	2.99 minutes
Average	.33	.57	.34	.17	.14	11.4	45.5	3.78 minutes
Center	.35	.41	.35	.21	.18	12.8	50.3	3.59 minutes

* Not Observed

TABLE 4

COMMUNICATION MESSAGE TYPE

Message Type*	Transitional Sectors		Low Altitude Sectors		High Altitude Sectors		All Sectors	
	Mean Message Time (Seconds)	Frequency of Occurrence	Mean Message Time (Seconds)	Frequency of Occurrence	Mean Message Time (Seconds)	Frequency of Occurrence	Mean Message Time (Seconds)	Frequency of Occurrence
100	0.0	.000	0.0	.000	0.0	.000	0.0	.000
110	3.0	.049	2.8	.019	3.2	.050	3.0	.036
120	0.0	.000	0.0	.000	0.0	.000	0.0	.000
130	3.2	.083	2.9	.066	3.0	.096	3.0	.080
140	0.0	.000	0.0	.000	3.5	.000	3.5	.000
150	3.8	.075	3.4	.058	4.0	.082	3.7	.070
160	3.7	.004	6.5	.006	0.0	.000	5.7	.004
170	2.0	.004	5.2	.005	0.0	.000	4.3	.003
180	0.0	.000	0.0	.000	0.0	.000	0.0	.000
200	0.0	.000	0.0	.000	0.0	.000	0.0	.000
210	2.5	.034	2.2	.030	1.9	.029	2.2	.031
220	2.6	.034	2.8	.044	2.4	.017	2.7	.033
230	3.1	.084	3.1	.123	2.9	.135	3.0	.118
240	0.0	.000	0.0	.000	0.0	.000	0.0	.000
250	0.0	.000	0.0	.000	0.0	.000	0.0	.000
300	0.0	.000	0.0	.000	0.0	.000	0.0	.000
310	3.7	.053	3.1	.061	3.4	.023	3.3	.046
320	2.7	.147	2.8	.151	2.7	.163	2.7	.154
330	3.1	.018	2.7	.010	2.2	.010	2.7	.012
340	2.0	.047	2.0	.077	1.9	.092	2.0	.075
350	2.3	.005	3.6	.013	6.0	.005	3.5	.009

*See Appendix B

TABLE 4 (Continued)

Message Type*	Transitional Sectors		Low Altitude Sectors		High Altitude Sectors		All Sectors	
	Mean Message Time (Seconds)	Frequency of Occurrence	Mean Message Time (Seconds)	Frequency of Occurrence	Mean Message Time (Seconds)	Frequency of Occurrence	Mean Message Time (Seconds)	Frequency of Occurrence
400	0.0	.000	0.0	.000	0.0	.000	0.0	.000
410	3.7	.053	3.7	.065	4.0	.058	3.8	.060
420	3.0	.003	3.6	.003	3.2	.002	3.4	.003
430	5.0	.011	4.8	.008	5.3	.011	5.1	.009
440	0.0	.000	2.0	.001	0.0	.000	2.0	.000
450	5.4	.055	4.9	.009	5.5	.014	5.3	.021
460	2.8	.030	2.5	.027	2.0	.002	2.6	.019
470	1.7	.000	3.9	.008	3.5	.002	3.6	.004
500	0.0	.000	0.0	.000	0.0	.000	0.0	.000
510	3.7	.019	3.2	.020	2.7	.011	3.2	.017
540	2.6	.005	3.2	.022	2.3	.010	2.9	.014
550	2.4	.003	3.0	.004	2.6	.003	2.8	.003
560	0.0	.000	3.1	.002	4.7	.005	4.0	.003
600	0.0	.000	0.0	.000	0.0	.000	0.0	.000
610	3.8	.014	2.3	.004	3.2	.004	3.1	.006
620	3.7	.008	4.3	.005	2.4	.003	3.5	.005
630	15.3	.009	6.1	.004	7.6	.029	7.9	.014
640	3.7	.153	3.7	.154	3.8	.145	3.7	.151
700	0.0	.000	0.0	.000	0.0	.000	0.0	.000
710	0.0	.000	0.0	.000	0.0	.000	0.0	.000
720	0.0	.000	0.0	.000	0.0	.000	0.0	.000

*See Appendix B

TABLE 5

COMMUNICATIONS ANALYSIS BY POSITIONS

Low Altitude	Avg. no. of Pilot CT's	Avg. no. of Controller CT's	Total no. of CT's/Hr.	Avg. Time of CT	Avg. no. of Aircraft	Avg. no. of CT's/Aircraft	Channel Utilization
D-1	13.6	26.4	40.0	12.9	10.4	3.8	.144
D-2	21.2	28.4	49.6	16.8	13.6	3.6	.232
D-3	41.6	64.8	106.4	12.0	25.6	4.2	.358
D-4	29.6	44.4	74.0	15.0	18.4	4.0	.310
D-5	21.6	40.8	62.4	12.1	11.6	5.4	.212
D-6	18.0	26.0	44.0	15.1	12.7	3.3	.186
D-20	9.2	13.2	22.4	16.4	6.4	3.5	.103
D-21	23.6	38.0	61.6	14.0	16.4	3.8	.240
D-22	10.0	19.6	29.6	11.1	9.2	3.2	.091
D-23	16.8	39.6	56.4	12.7	12.0	4.7	.202
D-24	13.2	28.4	41.6	15.1	6.8	6.1	.175
Avg.	19.8	33.6	53.4	13.7	13.0	4.1	.205
Transitional Sectors							
D-7	34.0	39.6	73.6	15.6	15.6	4.7	.322
D-8	31.6	43.2	74.2	16.6	18.4	4.1	.347
D-9	23.6	41.2	64.8	13.0	10.8	6.0	.236
D-10	21.2	36.0	57.2	15.1	8.4	6.8	.240
Avg.	27.6	40.0	67.6	15.1	13.3	5.1	.286

TABLE 5 (Continued)

High Altitude	Avg. no. of Pilot CT's	Avg. no. of Controller CT's	Total no. of CT's/Hr.	Avg. Time of CT	Avg. no. of Aircraft	Avg. no. of CT's/Aircraft	Channel Utilization
D-30	18.8	28.4	47.2	10.2	15.6	3.0	.134
D-31	24.8	31.2	56.0	12.3	14.8	3.8	.191
D-32	30.4	37.2	67.6	11.6	16.0	4.2	.219
D-34	20.8	25.2	46.0	15.0	10.8	4.3	.195
D-35	22.0	36.8	58.8	13.8	13.8	4.1	.242
D-41	30.0	44.0	74.0	10.2	22.0	3.4	.211
D-43	12.4	25.2	37.6	10.1	9.6	3.9	.105
D-44	2.8	6.8	9.6	12.7	2.0	4.8	.034
D-45	40.4	49.6	90.0	10.4	22.0	4.1	.264
D-46/47	12.8	8.0	20.8	13.6	4.0	5.2	.096
Avg.	21.5	29.2	50.8	11.7	13.1	3.87	.169
Summary for Center	21.8	32.9	54.7	13.2	13.1	4.16	.204

Prepared by:

Allen C. Busch
Project Manager

Approved by:

Lyle G. Alverson
Chief, Human Engineering Branch

APPENDIX A

ACTIVITY CODES AND DEFINITIONS

OF	ON FREQUENCY
SB	PREPARES SHRIMP BOAT
	MOVES SHRIMP BOAT
	CLEANS SHRIMP BOAT
GI	RECEIVES OR GETS GENERAL INFO
LC	LOOKS AT CHARTS, MAPS, WALL
RE	RECEIVES FLIGHT PLANS (ESTIMATES)
ID	ISSUES DEPARTURE CLEARANCES
RD	RECEIVES DEPARTURE TIMES
AB	ADJUSTS BEACON
AR	ANY MANIPULATION OF RADAR
CA	COORDINATES WITH "A" MAN
CC	COORDINATES WITH COORDINATOR
CD	COORDINATES WITH "D" MAN
CF	COORDINATES WITH ADJACENT FACILITY
CR	COORDINATES WITH "R" MAN
CS	COORDINATES WITH ADJACENT SECTOR
GHF	GIVES HANDOFF (FACILITY)
GHS	GIVES HANDOFF (SECTOR)
RHS	RECEIVES HANDOFF (SECTOR)
RHF	RECEIVES HANDOFF (FACILITY)
PES	PASSES ESTIMATES OR RELATED INFO (SECTOR)
PEF	PASSES ESTIMATES OR RELATED INFO (FACILITY)
RES	RECEIVES ESTIMATES (SECTOR)
REF	RECEIVES ESTIMATES (FACILITY)
PRS	PASSES REVISIONS (SECTOR)
PRF	PASSES REVISIONS (FACILITY)
RRS	RECEIVES REVISIONS (SECTOR)
RRF	RECEIVES REVISIONS (FACILITY)

BS	BUCKETS STRIPS
BL	BUNDLE STRIPS, FILING STRIPS, SEPARATING
DS	DELIVERS STRIPS TO PROPER SECTORS
FS	FILLS STRIP HOLDERS
MS	MARKS STRIPS
PS	PREPARES STRIPS, COMPLETE F. P. PROCESSING
SC	COUNT STRIPS
SK	CHECK STRIPS
SS	SEQUENCE STRIPS

INT	GENERAL INTERPHONE INFORMATION

APPENDIX B

MESSAGE TYPE

100 AIR TRAFFIC CONTROL INSTRUCTIONS
- 110 AIRCRAFT VECTORING/HEADING MESSAGE
- 120 HOLDING
- 130 ALTITUDE CONTROL
- 140 SPEED CONTROL
- 150 CLEARANCE CONTROL WITHOUT HOLDING INFORMATION
- 160 CLEARANCE CONTROL WITH HOLDING INFORMATION
- 170 AIR FILES
- 180 FLIGHT PLAN DELIVERY

200 ELECTRONIC COMMUNICATION SUPPORT MESSAGES
- 210 CALL-UP MESSAGE
- 220 BEACON CONTROL
- 230 HANDOFF/FREQUENCY CHANGES
- 240 BEACON DISCRETE CODE
- 250 MODE C AUTOMATIC ALTITUDE REPORTING

300 AIR TRAFFIC CONTROL SUPPORT
- 310 POSITION REPORT
- 320 ALTITUDE REPORT
- 330 VECTOR AND SPEED REPORTS
- 340 AIRCRAFT IDENTIFICATION
- 350 FACILITY SUPPORT

400 ADVISORY MESSAGES
- 410 AIRCRAFT TRAFFIC ADVISORY
- 420 AIRCRAFT STATUS
- 430 GENERAL WEATHER
- 440 AIRPORT STATUS
- 450 SPECIFIC WEATHER
- 460 ALTIMETER SETTING
- 470 FACILITY STATUS

500 COMMUNICATION INCIDENTS
- 510 NO CONTACT
- 520 BLANK
- 530 BLANK
- 540 COMMUNICATION EQUIPMENT CHECK
- 550 COMMUNICATION INCIDENTS
- 560 RELAYED MESSAGE

600 UNCLASSIFIABLE

- 610 MISCELLANEOUS MESSAGE
- 620 UNCLASSIFIABLE
- 630 AIRCRAFT-TO-AIRCRAFT MESSAGE
- 640 PAUSE

700 INCOMPLETE COMMUNICATION TRANSACTIONS

- 710 FIRST PORTION OF TEXT MISSING
- 720 LAST PORTION OF TEXT MISSING

VOICE MESSAGE TYPE DEFINITIONS

100 AIR TRAFFIC CONTROL INSTRUCTIONS

110 AIRCRAFT VECTORING/HEADING MESSAGE

A control instruction informing the pilot to modify his heading. This category also includes air-initiated requests related to heading changes.

120 HOLDING

Applies only to those control commands issued by local or ground control instructing pilots to hold somewhere on the ground.

130 ALTITUDE CONTROL

A control message directing the pilot to modify his present aircraft altitude. This category includes air-initiated requests for changes to aircraft altitude.

140 SPEED CONTROL

A control message directing the pilot to alter his air speed. This category also includes air-initiated requests for changes to aircraft speed.

100 (Continued)

150 CLEARANCE CONTROL WITHOUT HOLDING INFORMATION

A control message containing the pilot's clearance limit. It may or may not contain details of his routing and altitude. This category also includes air-initiated requests for changes to or information relating to aircraft clearance. It also covers takeoff, landing, and other clearances given in a terminal area. Clearances containing altitude, speed, or beacon code information are also coded to the appropriate category.

160 CLEARANCE CONTROL WITH HOLDING INFORMATION

A control message containing aircraft holding instructions. It pertains to airborne aircraft only, and includes all ground- or air-initiated messages relating to holding.

170 AIR FILES

Filing or refiling of flight plans by the aircraft in flight will be classified 170 in addition to any other appropriate category. Includes all messages pertaining to air filing as well as actual air filing of a flight plan.

180 FLIGHT PLAN DELIVERY

Filing of flight plans by the aircraft on the ground will be classified 180 in addition to any other appropriate category.

200 ELECTRONIC COMMUNICATION SUPPORT MESSAGES

210 CALL-UP MESSAGE

This message is defined as a simple, acknowledged, radio contact from either the controller or the aircraft. This class is not used if transmission includes any other type message.

200 (Continued)

220 BEACON CONTROL

Beacon control messages are those involving transponder checks, beacon code changes, or any control action modifying the transponder operation. It is mutually exclusive with 240 or 250.

230 HANDOFF/FREQUENCY CHANGE

It may be identified by noting the instructions given to the pilot to switch to another frequency and/or ATC facility. This message type includes those cases where an aircraft leaves the controller frequency for such reasons as cancellation of IFR flight plans.

240 BEACON DISCRETE CODE

This classification includes all transmissions involving the use of the 4096 discrete beacon codes. A discrete code is one in which the last two digits are not zeros. 240 messages may also be type 340 messages. It is mutually exclusive with 220.

250 MODE C AUTOMATIC ALTITUDE REPORTING

Messages relating to Mode C altitude readout information or the automatic altitude reporting equipment associated with a beacon-transponder.

300 AIR TRAFFIC CONTROL SUPPORT

310 POSITION REPORT

The pilot reports his present or future position in terms of a ground fix or distance therefrom. This includes ground-initiated reporting of, or requests for, present or future aircraft position.

300 (Continued)

320 ALTITUDE REPORT

This message type includes present altitude reports or requests for reports of future altitude by the controller. It does not include messages pertaining to altitude information provided by Mode C automatic reporting equipment.

330 HEADING AND SPEED REPORTS

This message type also includes ground-initiated requests for information relative to aircraft heading or speed.

340 AIRCRAFT IDENTIFICATION

All messages concerned with the process of identification of the occupant of particular airspace whether it is a visual sighting or a radar target. 340 messages may also be 220 messages. Messages requesting or reporting position and altitude solely or primarily for identification purposes will be classified as 340 in addition to any other appropriate category.

350 FACILITY SUPPORT

This category involves messages concerning the capability of a ground facility to furnish specific operational support or coverage. These messages supply the aircraft with advisories such as: radar service terminated; expect radar contact at (fix), (altitude); PAR service not available; etc. It does not include messages related to outages or breakdowns of equipment. These are covered in sections 440 or 470.

400 ADVISORY MESSAGES

410 AIRCRAFT TRAFFIC ADVISORY

These messages advise the pilot and/or controller of air traffic in the vicinity of the aircraft. This category also includes surface traffic advisories or information on any other ground situation not sufficiently general and/or enduring as to warrant broadcasting (on ATIS). This rule applies regardless of whether or not ATIS is actually operating in the area.

420 AIRCRAFT STATUS

These messages cover the status of all aircraft and air frame equipment with the exception of radio and/or communications equipment checks.

430 GENERAL WEATHER

This message type includes forecasts or current weather information closely related to the area of operation. It covers those weather items general or enduring enough to be handled by automatic voice or digital data communications links. Altimeter settings are not included in this class.

440 AIRPORT STATUS

This message category will include only information sufficiently general and/or durable as to warrant broadcast (on ATIS). This rule applies regardless of whether or not ATIS is actually operating in the area. Altimeter settings are excluded from this category. Includes all landing aids associated with an airport except VOR's and DME's.

450 SPECIFIC WEATHER

This classification covers pilot reports of observed weather and specific weather information supplied to the pilot which is not sufficiently general or enduring to be broadcast. It includes items of weather at locations too remote to be of interest to aircraft operating within the sector/terminal area. Altimeter settings are excluded from this category.

400 (Continued)

460 ALTIMETER SETTINGS

Any messages concerned with pressure reference setting for the altimeter. Unless aircraft altitude is actually requested or reported, messages in this category will not be classified also as 320 type message.

470 FACILITY STATUS

Any message pertaining to the operating status of a facility not sufficiently general or enduring to be broadcast. Includes all radars except PAR's and ASDE's.

500 COMMUNICATION INCIDENTS

510 NO CONTACT

This classification is applied to the Transmission which requires a response but to which no response is received. It also applies to cases where the caller is heard and not understood but the "caller" replies with a request for repeat and the repeat is not eventually successful. In this case the Transmission not understood is classified as type 511 and the request for repeat is classified as type 514. It might also be a type 560.

520 BLANK

530 BLANK

540 COMMUNICATION EQUIPMENT CHECK

This category is applied to those messages generated to check channel performance. It includes those messages requesting a change of frequency due to transmission or reception difficulties.

500 (Continued)

550 COMMUNICATION INCIDENTS

Any transmission in which the meaning of all or part of the text cannot be understood due to any type of communication incident will be classified as message type 550, in addition to any other message types which can be determined.

560 RELAYED MESSAGES

Any transmission which is relayed or which concerns the relaying of a message will be classified as type 560 as well as any other appropriate type.

600 UNCLASSIFIABLE

610 MISCELLANEOUS MESSAGE

Any transmission in which the starting time and duration is determinable and the contents of the text do not apply to any other message type definition will be classified message type 610.

620 UNCLASSIFIABLE

A transmission in which the starting time and duration is determinable but part or all of the text cannot be understood due to data reduction difficulties is classified as a message type 620 in addition to any other message types which can be determined. It also includes all transmissions containing more than six message types.

630 AIRCRAFT-TO-AIRCRAFT MESSAGE

This type is applied to non-ATC communications between two or more aircraft (whether on the ground or in the air). If the messages are relayed in support of air traffic control they are classified as 560 and any other appropriate type.

600 (Continued)

640 PAUSE

Any pause between transmissions which exceeds two seconds in duration will be treated as a separate transmission, and will be classified 640. Pause will be considered to be "originated" by the originator of the transmission being awaited. If pause exceeds 10 seconds it is treated as a separate transaction.

700 INCOMPLETE COMMUNICATION TRANSACTIONS

710 FIRST PORTION OF TEXT MISSING

A transmission in which the start time and the duration cannot be determined will be classified as message type 710.

720 LAST PORTION OF TEXT MISSING

A contact in which the finish time and the duration cannot be determined will be classified as message type 720.

MESSAGE TYPE OR CONTACT IDENTIFIER THIRD DIGIT DESIGNATIONS

XX0	None of following
XX1	The message type XX0 which was subsequently repeated/corrected
XX2	A message type XX0 which included statement "standby"
XX3	A message type which is both of above (XX1 and XX2)
XX4 (Asking)	Request (text). This is a request by the caller to be supplied information, be granted a clearance, perform a certain operation, etc.
XX5 (Telling)	Compliance or Response to an XX4 request. Includes a transmitter initiated report or information volunteered by the transmitter even though not requested.
XX6	Simple acknowledgment (of receipt of message) and/or concurrence. It is a mutually exclusive category with XX5.
XX7	Readback acknowledgment or message verification. It is not necessarily a verbatim repeat. It may be a paraphrase or a partial report of the message. It is a mutually exclusive category with XX5.